ECONOMIC CRASH IN THE 37th AND 36th CENTURIES cal. BC IN NEOLITHIC LAKE SHORE SITES IN SWITZERLAND

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Summary

Because of the exceptionally good preservation of organic material, the lakeside settlements in Switzerland allow a very detailed reconstruction of Neolithic economies. The density of the investigations of animal bones and plant remains in these settlements, dated between 4300 and 2400 cal. BC, is very high. For the Zürich Lake region the results for the 37th and 36th centuries indicate a fundamental change in economic conditions and lifestyle: increasing numbers of wild animal bones (especially red deer), remains of collected plants with high nutritional value, and changes in body sizes of fish coincide with a decrease in cereal production. During the same period, high numbers of wild animal bones are also noted for other regions like Lake Constance, Lake Zug, Lake Biel, Lake Neuchatel, and the lakes in the French Jura mountains (Lake Clairvaux). The wide geographic range of these phenomena suggests a relationship with climatic fluctuations. As a matter of fact, a climatic deterioration can be demonstrated for the Alpine region in this period, and is related to increasing lake levels in the lowland regions.

Résumé

Débâcle économique aux 37e et 36e siècles av. J.-C. (cal.) dans les sites néolithiques lacustres de Suisse.

La conservation exceptionnelle de la matière organique permet, dans les stations en bord des lac de Suisse, une reconstitution très détaillée de la vie économique au Néolithique. Les études concernant les ossements d'animaux et les restes végétaux sont très nombreuses pour la période allant de 4300 à 2400 av. J.-C. Dans la région du Lac de Zürich, les résultats obtenus pour ce qui concerne les 37e et 36e siècles montrent un changement fondamental des conditions de l'économie et du mode de vie : l'accroissement du nombre d'ossements d'animaux sauvages (du cerf en particulier), de vestiges alimentaires de plantes ainsi que les variations de la taille des poissons, vont de pair avec la diminution de la production céréalière. Pour la même période, on retrouve un nombre tout aussi élevé d'ossements d'espèces sauvages dans d'autres régions, telles que le Lac de Constance ou ceux de Zoug, de Bienne ou de Neuchâtel et les lacs du Jura français tels que le Lac de Clairvaux. Le caractère extensif de ces phénomènes montre qu'ils sont liés aux fluctuations climatiques. Le fait est que, pour cette période, dans la région alpine, on a mis en évidence une détérioration du climat (activité accrue des glaciers, diminution de la forêt), phénomène que l'on peut lier à une montée du niveau des lacs dans les zones basses.

Zusammenfassung

Wirtschaftlicher Zusammenbruch in neolithischen Ufersiedlungen der Schweiz (37.-36. Jh. v. Chr.).

Wegen der außerordentlich guten Erhaltung organischer Materialien erlauben die Ufersiedlungen der Schweiz genaue Rekonstruktionen neolithischer Wirtschaftsweisen. Die Anzahl der Knochen- und Pflanzenreste ist in diesen Siedlungen, die zwischen 4300 und 2400 BC cal. datieren, sehr hoch. Für das Gebiet um den Zürichsee deuten die Untersuchungsergebnisse für den Bereich des 37. und 36. Jh. einen grundlegenden Wandel in Wirtschafts- und Lebensweise an: die Zunahme an Wildtierknochen (besonders Rothirsch), Sammelpflanzen mit hohem Nährwert sowie Veränderungen in der Körpergröße von Fischen fallen mit einem Rückgang der Getreideproduktion zusammen. Im gleichen Zeitabschnitt können auch in anderen Gegenden, an Bodensee, Zuger See, Bieler See, Neuenburger See und den Seen des Französischen Jura (Lac Clairvaux), hohe Anteile an Wildtierknochen festgestellt werden. Die große geographische Verbreitung dieses Phänomens läßt an einen Zusammenhang mit klimatischen Schwankungen denken. Tatsächlich kann eine Klimaverschlechterung für den alpinen Bereich nachgewiesen werden. Sie verursacht einen Anstieg der Seepegel im Alpenvorland.

Key Words

Neolithic, Economy, Climatic changes, Lake shore sites, Switzerland.

Mots clés

Néolithique, Économie, Changement de climat, Sites lacustres, Suisse.

Schlüsselworte

Neolithikum, Wirtschaft, Klimaschwankungen, Seeufersiedlungen, Schweiz.

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Introduction

The Neolithic and Bronze Age lakeside settlements of Switzerland and southern Germany offer excellent conditions for archaeobiological investigations. The archaeological layers lie mostly below the ground water level, where anaerobic conditions provide the necessary environment for the preservation of organic material. Not only are animal bones well preserved, but a variety of plant remains are also often recovered, including seeds, fruits, wood and leaves. In some exceptional circumstances, there are even plant remains which have retained their original green color.

During the last 20 years, dozens of lakeside sites in the northern Alpine foreland have been investigated using modern excavation techniques. In a number of projects, archaeobotanical and archaeozoological investigations have been carried out parallel to the traditional archaeological interpretations, leading to a dramatic increase in data on prehistoric economy and ecology. In 1990, an overview of the archaeozoology of the northern Alpine foreland was published, based on the combined results of a total of 63 Neolithic occupation phases (Schibler and Suter, 1990). Based on the latest investigations, largely carried out in the Archaeozoology Department at the University of Basel, our interpretations rest on a total of 111 occupation phases, divided among 33 sites (Schibler and Chaix, 1995). Sixty-five of these phases lie in the western and central Alpine foreland (here summarized as the western region); 46 lie in the eastern region (fig. 1). These 111 occupations have yielded a total of over 220,000 bones, with 85 taxa represented (including mammals, birds and fish).

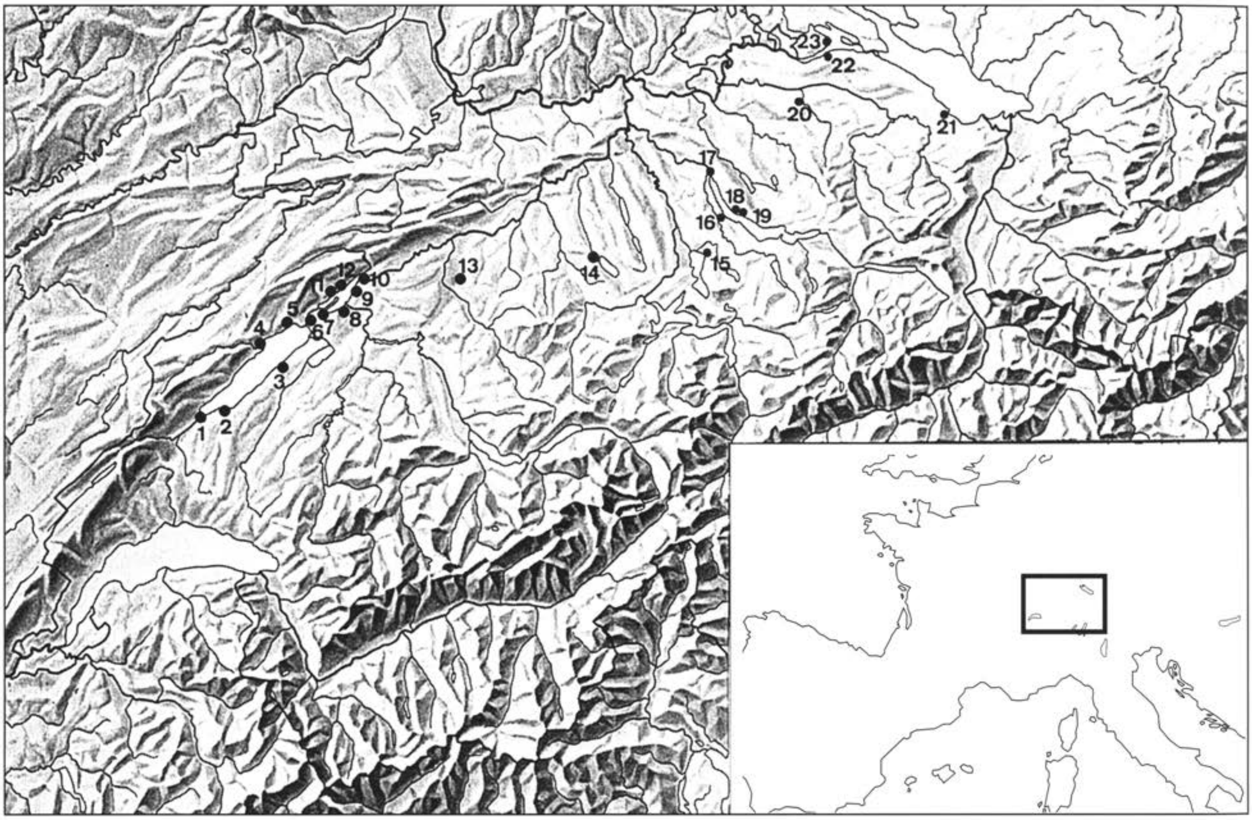

Fig. 1: Geographical distribution of the Neolithic lake shore sites in the northern Alpine foreland, which supplied archaeozoological assemblages.
1, Yverdon-Garage Martin; 2, Yvonand station III et IV; 3, Portalban-Les Grèves; 4, Auvernier-La Saunerie, Auvernier-Brise Lames, Auvernier-Port; 5, St. Blaise-Bains des Dames; 6, Thielle Wavre-Port de Thielle; 7, Vinelz-Strandboden, Vinelz-Grabung Strahm 1960, Vinelz-Hafeneinfahrt, Vinelz-Alte Station; 8, Lüscherz-Binggeli, Lüscher-Dorf-Äussere Station, Lüscherz-Fluhstation; 9, Lattrigen VI, Sutz-Rüte; 10, Nidau-BKW 5, Nidau-BKW 3; 11, La Neuville-Chavannes; 12, Twann E1-9, Twann UH, Twann MH, Twann OH; 13, Seeberg-Burgäschisee SW, Seeberg-Burgäschisee Süd; 14, Egolzwil 3, Egolzwil 5; 15, Zug-Vorstadt; 16, Horgen-Dampfschiffsteg; 17, Zürich-Kleiner Hafner, Zürich-Mozartstrasse, Zürich-Seefeld Kan. San., Zürich-Pressehaus, Zürich-AKAD/Pressehaus, Zürich-Mythenschloss; 18, Feldmeilen-Vorderfeld; 19, Meilen-Rohrenhaab; 20, Gachnang-Niederwil-Egelsee; 21, Arbon-Bleiche 3; 22, Steckborn-Turgi, Steckborn-Schanz; 23, Hornstaad-Hörnle I (BRD).

The Neolithic sites considered here date from approximately 4300 cal. BC to 2400 cal. BC (tab. 1). They do not include the earliest Neolithic sites in Switzerland, which lie in Wallis, Tessin and along the northern border of the country and date to about 5500 cal. BC. In this analysis, only those assemblages are considered which could be securely dated to within a century.

The division of assemblages between these two regions can be seen in table 1 and figure 2. Both figures show that western Switzerland provides a greater number of large assemblages. However, even the data base for eastern Switzerland can be considered good, since the abundance of assemblages and their close temporal sequence compensates somewhat for their smaller sample sizes (100-300 identifiable bones).

The relative importance of wild and domestic animals

The relative abundances of domestic and wild animals show dramatic changes during this 1900 year developmental sequence of lakeside occupations. In the earliest settlements, dating to 4300 cal. BC, domestic animal remains usually account for at least 50% of the total bone assemblage. There are no indications of local domestication of native taxa. Figure 3 shows the domestic animal percentages for the following occupation periods, in which strong shifts can be seen for both eastern and western Switzerland. The lowest proportion of domestic animals lies at about 10%, the highest at over 95%. Finally, at the end of this developmental sequence we see predominantly high percentages of domestic animals, often over 80%. This suggests an intensification in the use of domestic animals by the inhabitants of these lakeside sites. The abundance of settlements and their tight chronological control allow us to interpret these as long-term, gradual trends, rather than as short-term, random fluctuations.

One of these trends can be seen in eastern Switzerland, which shows a decrease of over 60% in the percentage of domestic animals, and a corresponding increase in the abundance of wild taxa (figs. 3 and 4). What economic changes could account for this dramatic shift in domestic and wild animal use? Are disruptions of local animal breeding responsible? Was there an increase in hunting activity? Or did both of these factors contribute to this overall pattern?

The traditional calculation of domestic and wild animal contributions based on number of fragments, bone weight or MNI provide no further help in answering these questions. The problem of closed sums prevents a clear interpretation of absolute increases or decreases in either of these major taxonomic groups. The only possible measure which can provide an independent form of quantification is density of bone per unit volume of sediment or per occupation phase (Stöckli, 1990). This calculation eliminates many of the problems associated with relative percentages. Therefore, we have figured the densities of wild and domestic animal bones per square meter for each occupation phase. Dendrochronological dating of these sites allows the definition of numerous, short occupation phases. These phases can be identified on the basis of intensive rebuilding or renovating of individual houses and/or of entire settlements. The average length of time between such renovations is usually on the order of 20 years. Accordingly, we have summarized our calculation of number of bone fragments per square meter and occupation phase in +/-20 year intervals. We are aware that this calculation is somewhat coarse and inexact, and cannot support the interpretation of very small differences. Nevertheless, this method of quantification has the advantage of avoiding the closed sums problem inherent in percentages. At this stage, the average number of bones per square meter and occupation phase can only be calculated on the basis of the assemblages from the shores of Lake Zürich. Bone density values for wild and domestic animals from various lakeside sites around Zürich are presented in Figure 5. Here it becomes clear that the change in proportions of wild to domestic animals between 3800 and 3600 cal. BC is due solely to an increase in the amount of wild animal bones, while the amount of domestic animals remains more or less constant in this time period.

Economic developments between 3800 and 3500 cal. BC

The density values for the domestic and wild animals from sites in the Zürich region show a strong intensification in hunting activity between 3800 and 3600 cal. BC. There is no apparent sign of interruptions in the local domestic animal breeding. In both centuries, cattle is the dominant domestic animal, followed by pig. Sheep and goat do not appear to have been critical for the economies of these lakeside settlements. Red deer was the most important wild animal. The peak in wild animal exploitation in the 37th and 36th centuries cal. BC indicates primarily an intensification in the hunting of red deer (fig. 4). With a constant use of domestic taxa, this would have had the effect of an increase in meat production in the economy in general. Why was more meat needed in this period of settlement? Neither settlement size nor house size increased at this time. We can assume, therefore, that a village population of about the same size consumed greater

Table 1: List of settlements yielding archaezoological assemblages.

Time BC cal.	Central and Western part of Switzerland		Eastern part of Switzerland	
	Site	**Literature**	**Site**	**Literature**
2500	St. Blaise Bains des Dames H	Stopp, in prep.		
	St. Blaise Bains des Dames G	Stopp, in prep.		
	St. Blaise Bains des Dames F	Stopp, in prep.		
	St. Blaise Bains des Dames E	Stopp, in prep.	Zürich Mythenschloss 2.1	Schibler *et al.*, in prep.
	St. Blaise Bains des Dames Auv.	Stopp, in prep.	Zürich Mozartstrasse 2 oben	Schibler *et al.*, in prep.
2600	Auvernier La Saunerie	Stampfli, 1976b	Zürich Mozartstrasse 2 unten	Schibler *et al.*, in prep.
	Vinelz Alte Station NW	Marti-Grädel, in prep.	Zürich Mythenschloss 2.2-3	Schibler *et al.*, in prep.
	Sutz Rüte	Marti-Grädel, in prep.	Zürich Seefeld Kan.San. A	Schibler *et al.*, in prep.
			Zürich Mythenschloss 2.4	Schibler *et al.*, in prep.
			Zürich Seefeld Kan.San. C/B	Schibler *et al.*, in prep.
			Zürich Seefeld Kan.San. D	Schibler *et al.*, in prep.
2700	Lüscherz Fluhstation	Marti-Grädel, in prep.	Zürich Pressehaus C2	Schibler *et al.*, in prep.
	Vinelz Hafeneinfahrt	Marti-Grädel, in prep.	Zürich Seefeld Kan.San. E	Schibler *et al.*, in prep.
	Lüscherz Dorf, Äussere Station	Marti-Grädel, in prep.	Zürich Seefeld Kan.San. F	Schibler *et al.*, in prep.
	Thielle Wavre, Pont-de-Thielle	Chaix, 1977		
	Auvernier Brise-Lames	Desse, 1976		
	St. Blaise Bains des Dames 7	Stopp, in prep.		
	Yverdon Garage Martin 11-12	Chaix, 1976 b		
2800	Yvonand 4	Clutton-Brock, 1990	Zürich Kleiner Hafner 2A-D	Schibler, 1987
	Vinelz Grabung Strahm 1960	Stampfli, 1966		
	Vinelz Strandboden	Marti-Grädel, in prep.	Feldmeilen Vorderfeld 1x	Schibler *et al.*, in prep.
2900			Feldmeilen Vorderfeld 1y	Schibler *et al.*, in prep.
			Feldmeilen Vorderfeld 1z	Schibler *et al.*, in prep.
			Zürich Pressehaus E	Schibler *et al.*, in prep.
3000			Meilen Rohrenhaab 2	
	Nidau BKW 3	Glass, unp.		
	Twann OH	Stampfli, 1980	Zürich Seefeld Kan.San. 2	Schibler *et al.*, in prep.
3100			Zürich Mozartstrasse 3 oben	Schibler *et al.*, in prep.
	St. Blaise Bains des Dames 9	Stopp, in prep.	Zürich Mozartstrasse 3 allg.	Schibler *et al.*, in prep.
	Lüscherz Binggeli	Marti-Grädel, in prep.	Zürich Mozartstrasse 3 unten	Schibler *et al.*, in prep.
	Portalban Les Grèves	Chaix *et al.*, 1983	Zürich Mythenschloss 3	Schibler *et al.*, in prep.
	La Neuville-Chavannes	Marti-Grädel, in prep.	Zürich Pressehaus G	Schibler *et al.*, in prep.
	Twann MH	Stampfli, 1980	Zürich Seefeld Kan.San. 3	Schibler *et al.*, in prep.
3200			Zürich Kleiner Hafner 3A+B	Schibler *et al.*, in prep.
			Zürich Seefeld Kan.San. 4	Schibler *et al.*, in prep.
			Feldmeilen Vorderfeld 3	Schibler *et al.*, in prep.
			Feldmeilen Vorderfeld 4	Schibler *et al.*, in prep.
3300				
	Lattrigen VI	Glass, unp.		
3400	Twann UH	Stamplfi, 1980	Arbon Bleiche	Markert, 1985a

	Nidau BKW 5	Glass, unp.		
3500	Twann E9	Becker and Johansson, 1981	Zug Vorstadt total	Rehazek and Schibler, unp.
	Twann E8	Becker and Johansson, 1981	Steckborn Schanz	Markert, 1985b
	Auvernier Port III	Chaix, 1985	Zürich Seefeld Kan.San. 5	Schibler *et al.*, in prep.
	Yverdon Garage Martin 14-16b	Chaix, 1976b		
	Twann E7	Becker and Johansson, 1981		
	Twann E6	Becker and Johansson, 1981		
3600	Yverdon Garage Martin 18-20	Chaix, 1976b	Zürich Mozartstrasse 4 oben	Schibler *et al.*, in prep.
	Twann E5a	Becker and Johansson, 1981	Zürich Mozartstrasse 4 mitte	Schibler *et al.*, in prep.
			Zürich Mozartstrasse 4 unten	Schibler *et al.*, in prep.
			Zürich Seefeld Kan.San. 6	Schibler *et al.*, in prep.
	Twann E5	Becker and Johansson, 1981	Meilen Rohrenhaab 3	Sakellaridis, 1979
	Egolzwil 5	Stampfli, 1976a	Horgen Dampfschiffsteg	Sakellaridis, 1979
			Meilen Rohrenhaab 4/4a	Sakellaridis, 1979
			Gachnang Niederwil	Clason, 1991
	Twann E4	Becker and Johansson, 1981	Zürich AKAD/Pressehaus J	Schibler *et al.*, in prep.
	Twann E3	Becker and Johansson, 1981	Zürich Seefeld Kan.San. 7	Schibler *et al.*, in prep.
3700	Auvernier Port Va	Chaix, 1985	Zürich Seefeld Kan.San. 8	Schibler *et al.*, in prep.
			Feldmeilen Vorderfeld 5	Schibler *et al.*, in prep.
			Feldmeilen Vorderfeld 6	Schibler *et al.*, in prep.
			Feldmeilen Vorderfeld 7	Schibler *et al.*, in prep.
			Feldmeilen Vorderfeld 8	Schibler *et al.*, in prep.
	Buräschisee Süd	Boessneck *et al.*, 1963	Feldmeilen Vorderfeld 9	Schibler *et al.*, in prep.
	Auvernier Port Vb-c	Chaix, 1985	Zürich Pressehaus L	Schibler *et al.*, in prep.
	Burgäschisee SW	"Josien, 1956 ; Stampfli, 1964"	Zürich Seefeld Kan.San. 9	Schibler *et al.*, in prep.
3800	Twann E1+2	Becker and Johansson, 1981	Zürich Kleiner Hafner 4G	Schibler, 1987
	Yvonand III 1+2	Chaix, 1976a	Zürich Mozartstrasse 5 oben	Schibler *et al.*, in prep.
			Zürich Mozartstrasse 5 unten	Schibler *et al.*, in prep.
			Zürich Kleiner Hafner 4F	Schibler, 1987
			Meilen Rohrenhaab 5	Sakellaridis, 1979
			Steckborn Turgi	Markert, 1985c
3900			Zürich Kleiner Hafner 4E	Schibler, 1987
			Zürich Kleiner Hafner 4D	Schibler, 1987
			Zürich Mozartstrasse 6 oben	Schibler *et al.*, in prep.
			Zürich Mozartstrasse 6 unten	Schibler *et al.*, in prep.
4000			Hornstaad Hörnle I AHA	Kokabi, 1990
4100			Zürich Kleiner Hafner 4C	Schibler, 1987
			Zürich Kleiner Hafner 4B	Schibler, 1987
4200			Zürich Kleiner Hafner 4A	Schibler, 1987
4300	Egolzwil 3	Stampfli, 1992	Zürich Kleiner Hafner 5A+B	Schibler, 1987

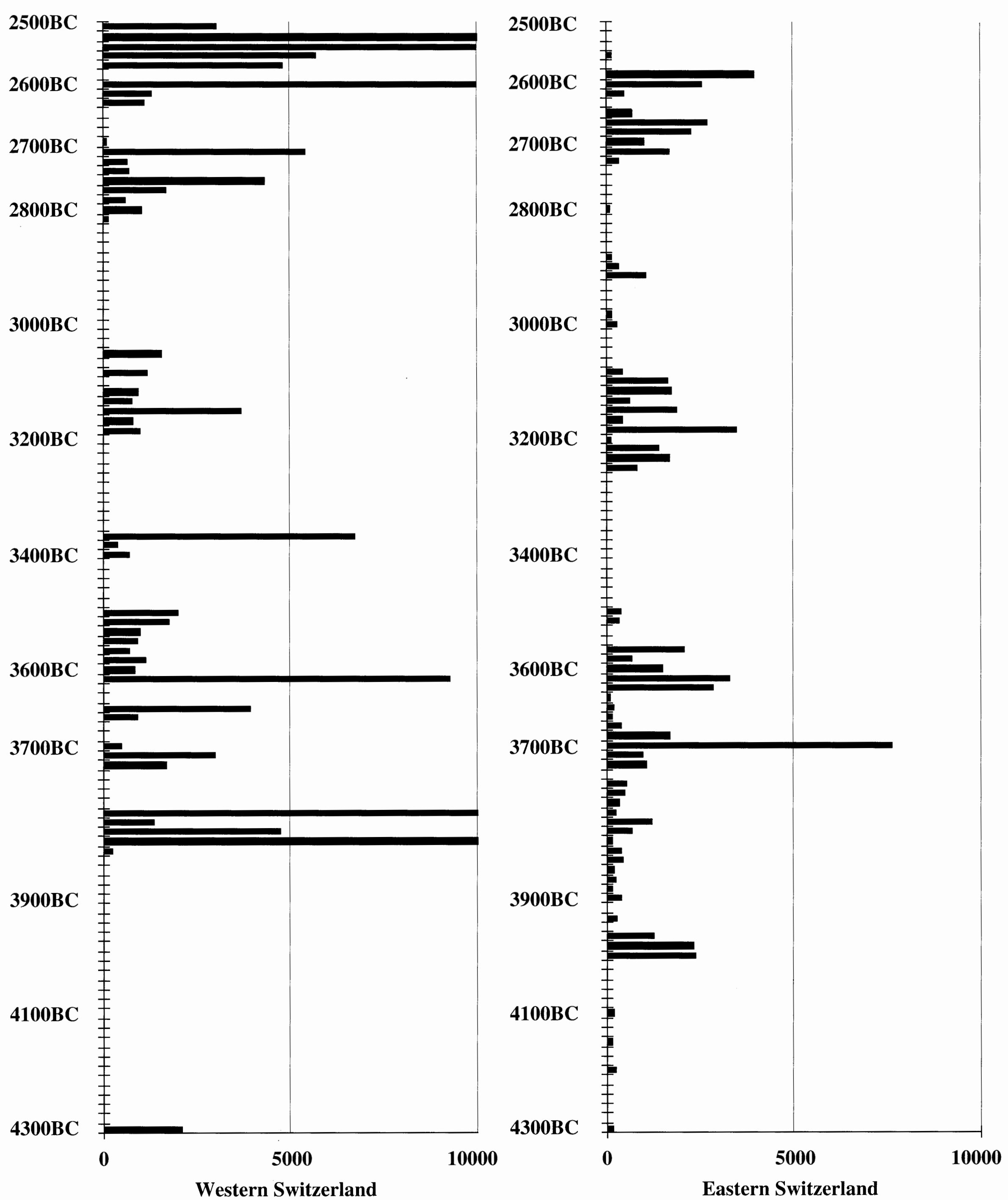

Fig. 2: Numbers of identified animal bones in the occupation phases.

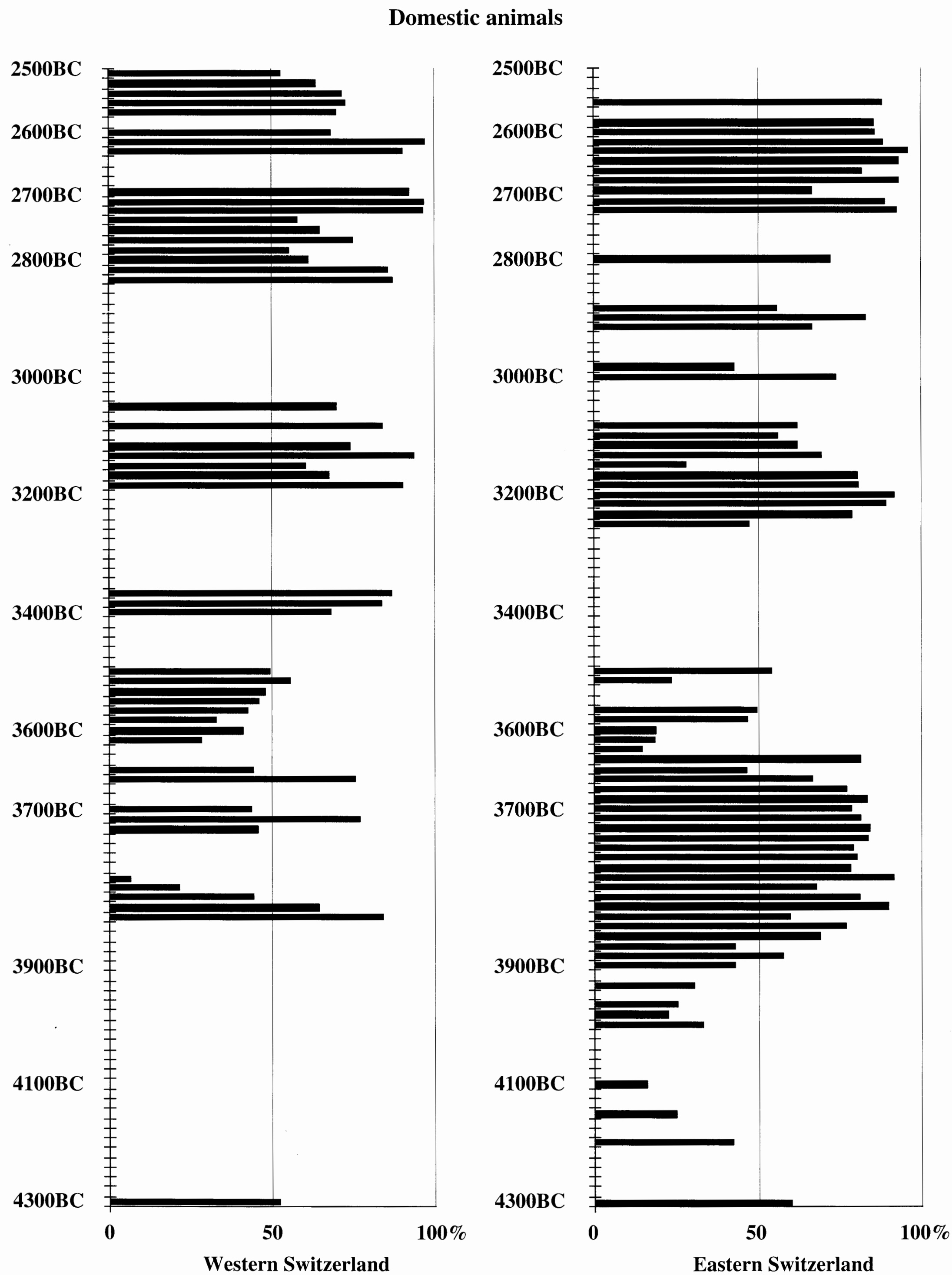

Fig. 3: Frequencies of domestic animal bones in the Neolithic occupation phases of the eastern and the western parts of Switzerland.

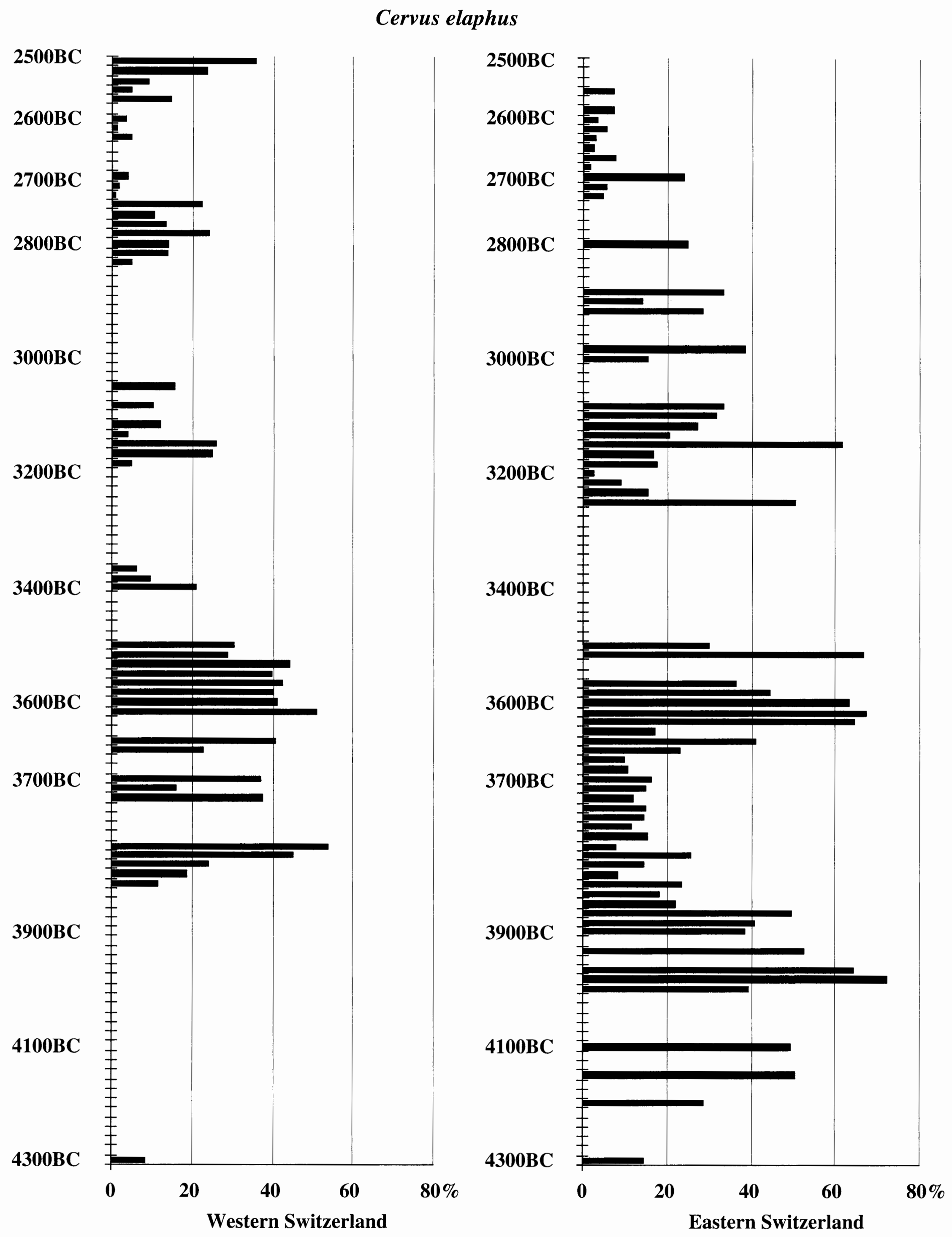

Fig. 4: Frequencies of red deer bones in the Neolithic occupation phases of the eastern and the western part of Switzerland.

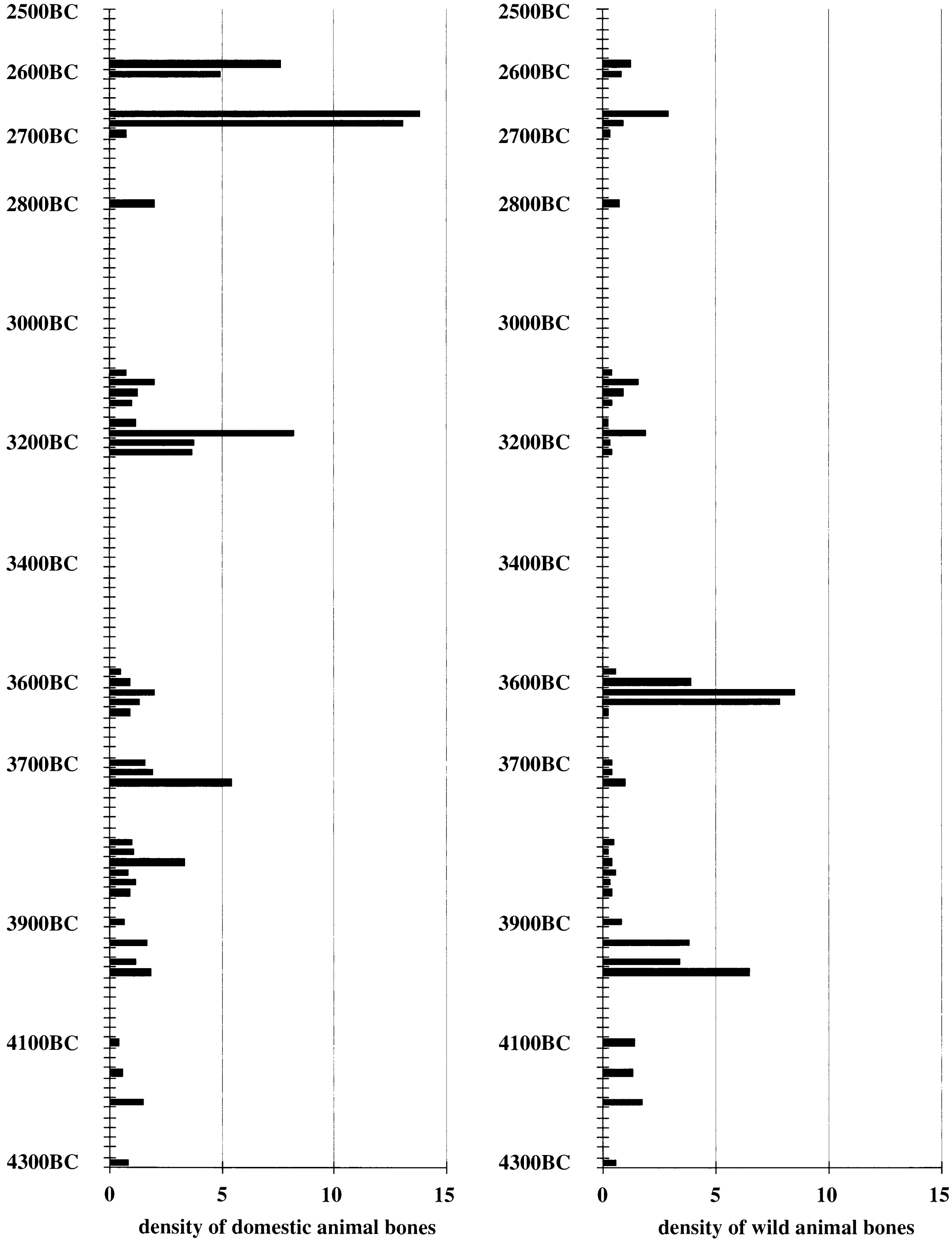

Fig. 5: Densities (number of bones per square meter and per occupation phase) of domestic and wild animal bones in Neolithic Zürich Lake sites.

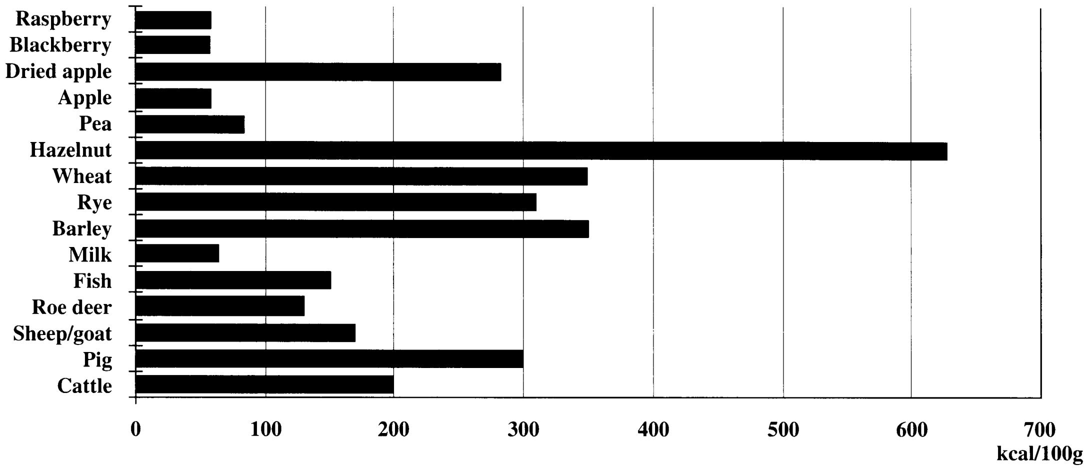

Fig. 6: Mean caloric yield per 100g of selected plant and animal foods.

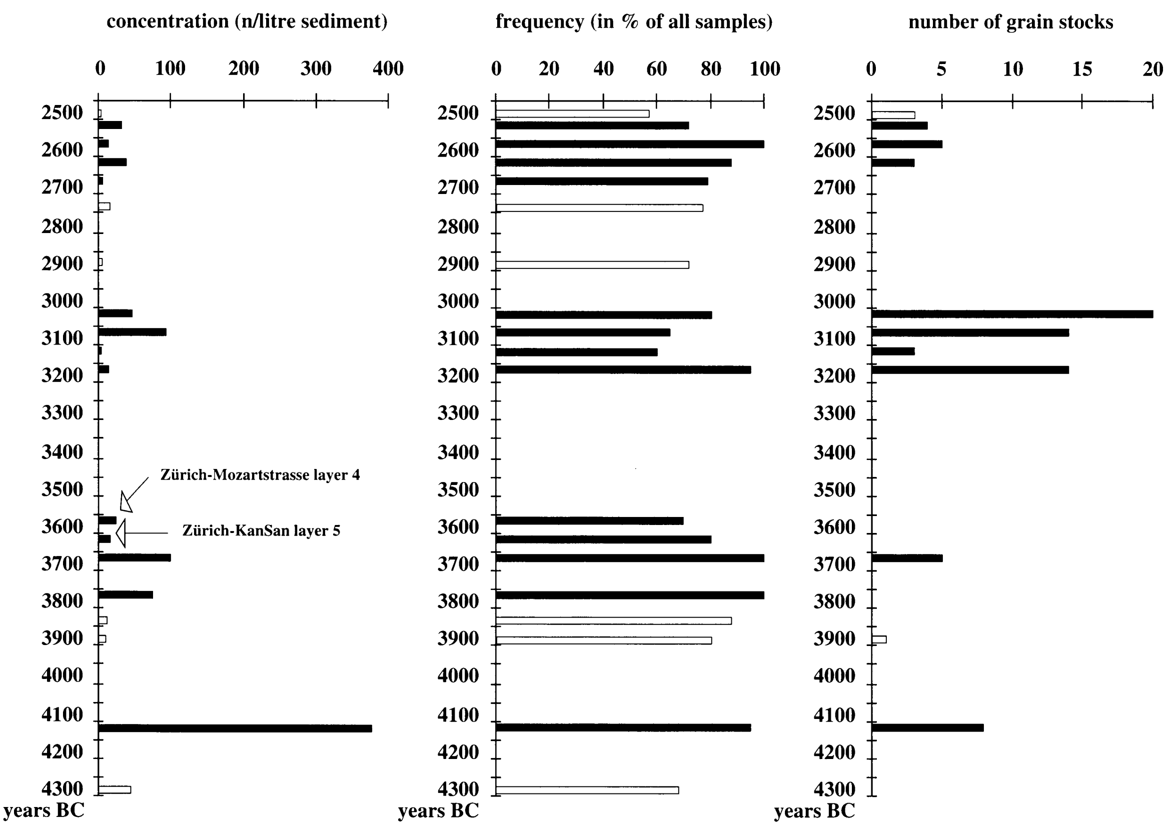

Fig. 7: Ubiquities and densities of cereal remains and the number of grain stocks from layers in Zürich Lake sites. Black bars: good preservation. White bars: bad preservation. Layer 4 from Zürich-Mozartstrasse and layer 5 from Zürich-Kan. San belong to the same settlement.

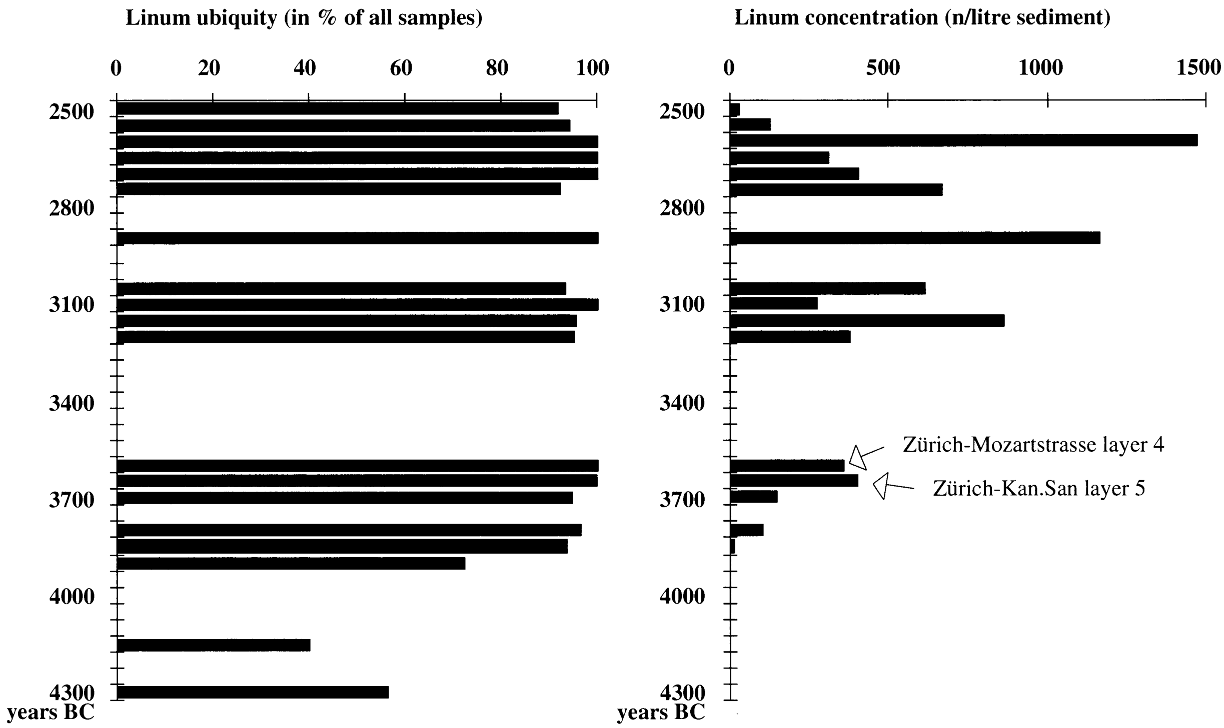

Fig. 8: Ubiquities and densities of flax remains (seeds and capsules) from layers in Zürich Lake sites. Layer 4 from Zürich-Mozartstrasse and layer 5 from Zürich-Kan.San belong to the same settlement.

quantities of meat in their diet. Since the density values for domestic animals remain constant, ruling out a disruption of this segment of the economy, interruptions of the plant nutritional system may be indicated. Because cereals represent the most important calorie source among the cultivated plants (fig. 6; Gross *et al.*, 1990), some problems in cereal cultivation may be suggested. The most important cultivated cereals in the period in question were naked wheat (tetra- or hexaploid) and barley.

Methodologically, it is difficult to determine if there was a decrease in cereal cultivation, since the presence and abundance of plant remains is so dependent on preservation conditions of the individual layers. Events which lead to good preservation, like widescale village fires, did not always occur in periods when grain stores were full. Following the criteria suggested by Jacomet *et al.* (1989) for the evidence of cereal cultivation, the cultural layers from the second half of the 37th century cal. BC do indeed look unusually poor in remains, even though the preservation conditions were good: the density of remains is low, ubiquity values fall to below 80%, and there is an absence of concentrations which could be interpreted as stored reserves.

Figure 7 shows that there were other cultural layers with comparable low amounts of cereals and a lack of stored remains. However, with one exception from the 27th century cal. BC (Zürich-Kan.San: layer D), these are all very poorly preserved, and therefore should not be compared with those of the previous millennium.

Apparently, the increase in deer hunting and corresponding increase in meat consumption was one way to compensate for the calories lost through the interruption of cereal cultivation. However, as shown in Figure 6, wild animal meat is a particularly poor source of calories. Additional sources must also have been intensified, in order to fully make up for the loss of nutrition from cereals. This seems to have taken place through an increased cultivation of flax (fig. 8), accompanied by an increase in wild plant gathering, especially wild plants with seeds and fruits rich in fat or carbohydrates. Layer 4 at Zürich-Mozartstrasse

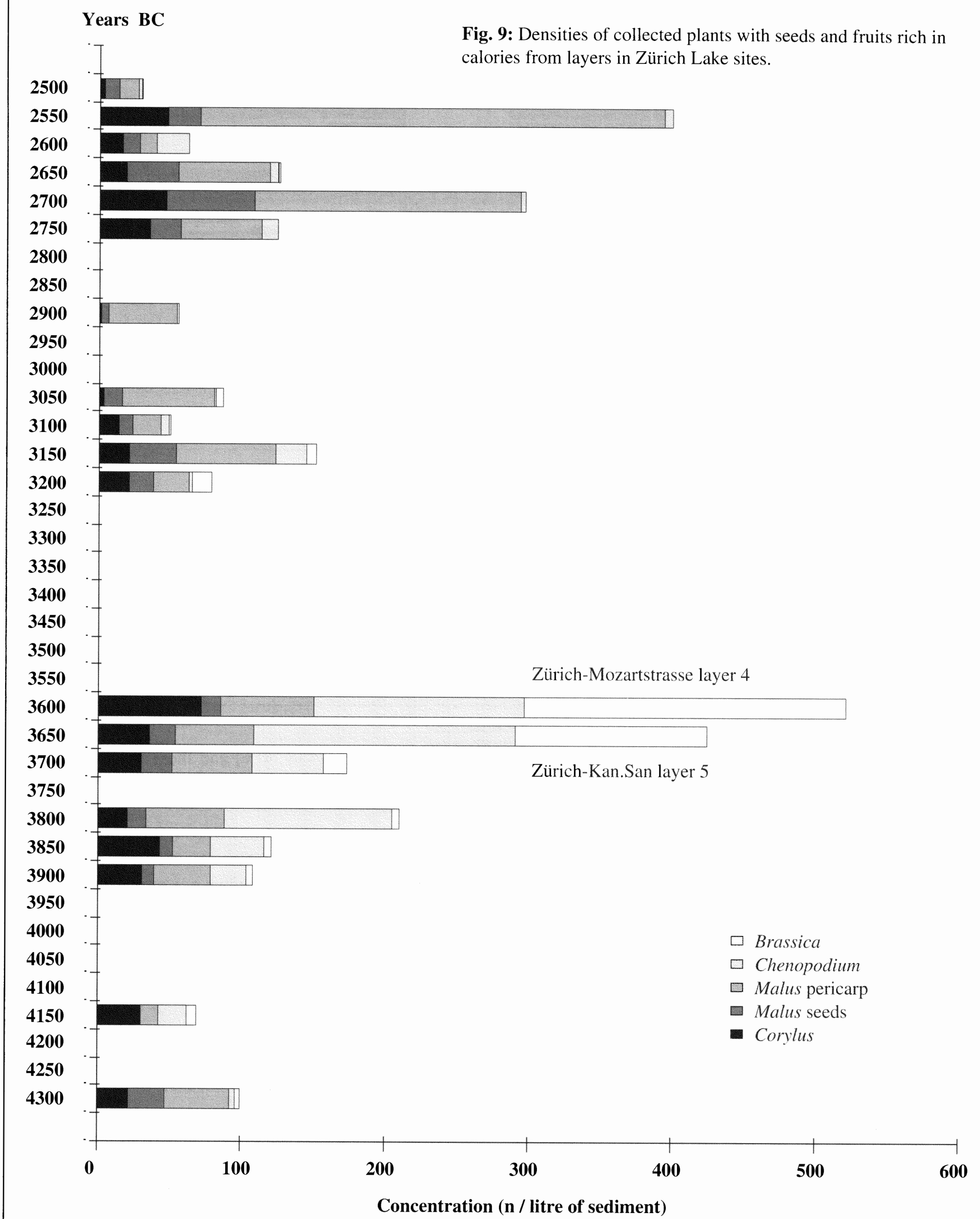

Fig. 9: Densities of collected plants with seeds and fruits rich in calories from layers in Zürich Lake sites.

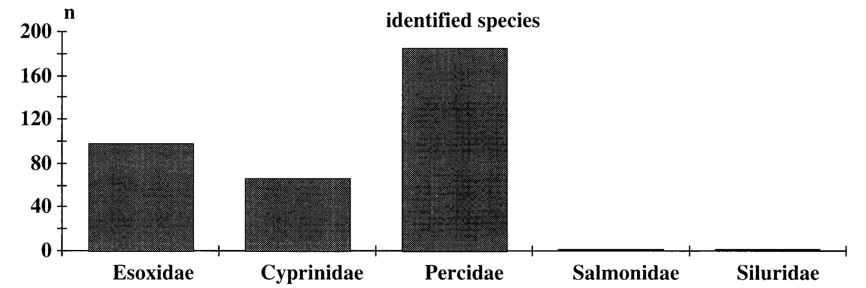

Fig. 10: Fish taxa recovered of the occupation phases of the site Zürich-Mozartstrasse (layers: 5 + 6 Cortaillod; 4 Pfyn; 3 Horgen; 2 Corded Ware).

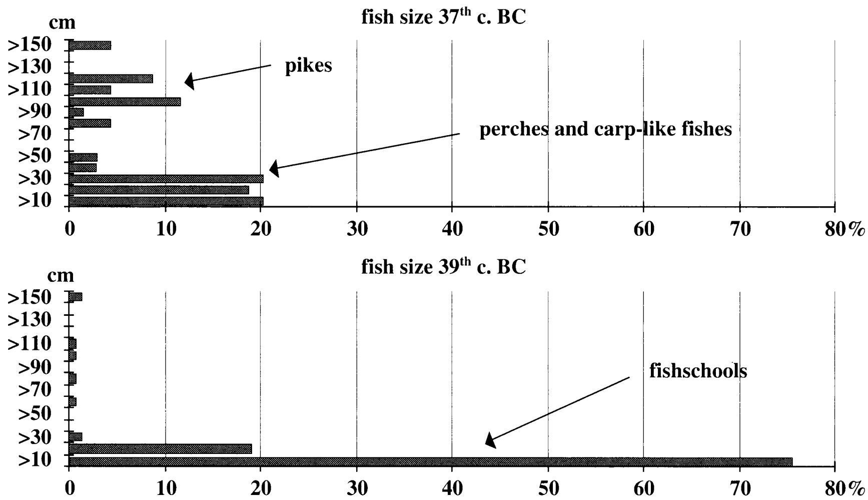

Fig. 11: Size classes of fish taxa in Cortaillod (39th century cal. BC) and Pfyn (37th century cal. BC) settlements from Zürich-Mozartstrasse.

and the contemporaneous layer 5 (Zürich Kan.San), dating to the second half of the 37th century cal. BC, show an extreme increase in wild plant exploitation (fig. 9; Brombacher et Jacomet, in prep). Especially important plants include turnip (*Brassica rapa*), containing seeds rich in oils, hazelnuts (*Corylus avellana*), an important fat source, and white goosefoot (*Chenopodium album*), with its carbohydrate-rich seeds.

The various changes demonstrated above for the second half of the 37th century cal. BC appear to have shared a common goal: the inhabitants of the Zürich lakeside sites were attempting to make up for calories lost from cereal cultivation by increasing their exploitation of a variety of local, wild resources.

The importance of fishing

At the present time, no systematic investigations of fish remains from Swiss Neolithic lakeside sites have been published. Fine screening and water sieving have only occassionally been carried out at individual excavations. There is a pressing need for a more representative picture of the relative importance of fishing in this economic system. Remains from larger taxa, like pike, naturally tend to dominate in the levels excavated using standard collection methods. However, these remains can hardly be interpreted as reflective of the importance of fishing in lakeside economies. The interpretations presented here stem from analysis of remains from Zürich-Mozartstrasse, which yielded series of fish bones from fine-screen samples (Jacomet *et al.*, 1989) in addition to those identified from the general faunal assemblage. The following conclusions are based on a total of 344 identified fish remains.

In the Neolithic, the Zürich Lake was a calcium-rich, oligotrophic lake (Jacomet 1985). The deeper waters contained predominantly salmon-like fish, such as whitefish, lake trout and charr, while the shallower shore zones supported a variety of carp species, perch, pike and burbot. The spectrum of fish represented in Zürich-Mozartstrasse includes a number of these shore-zone dwellers (fig. 10): pike (*Esox lucius*), various carp (Cyprinidae), and perch (*Perca fluviatilis*) are the most abundant. Lake trout (*Salmo trutta lacustris*) and catfish (*Silurus glanis*) are represented

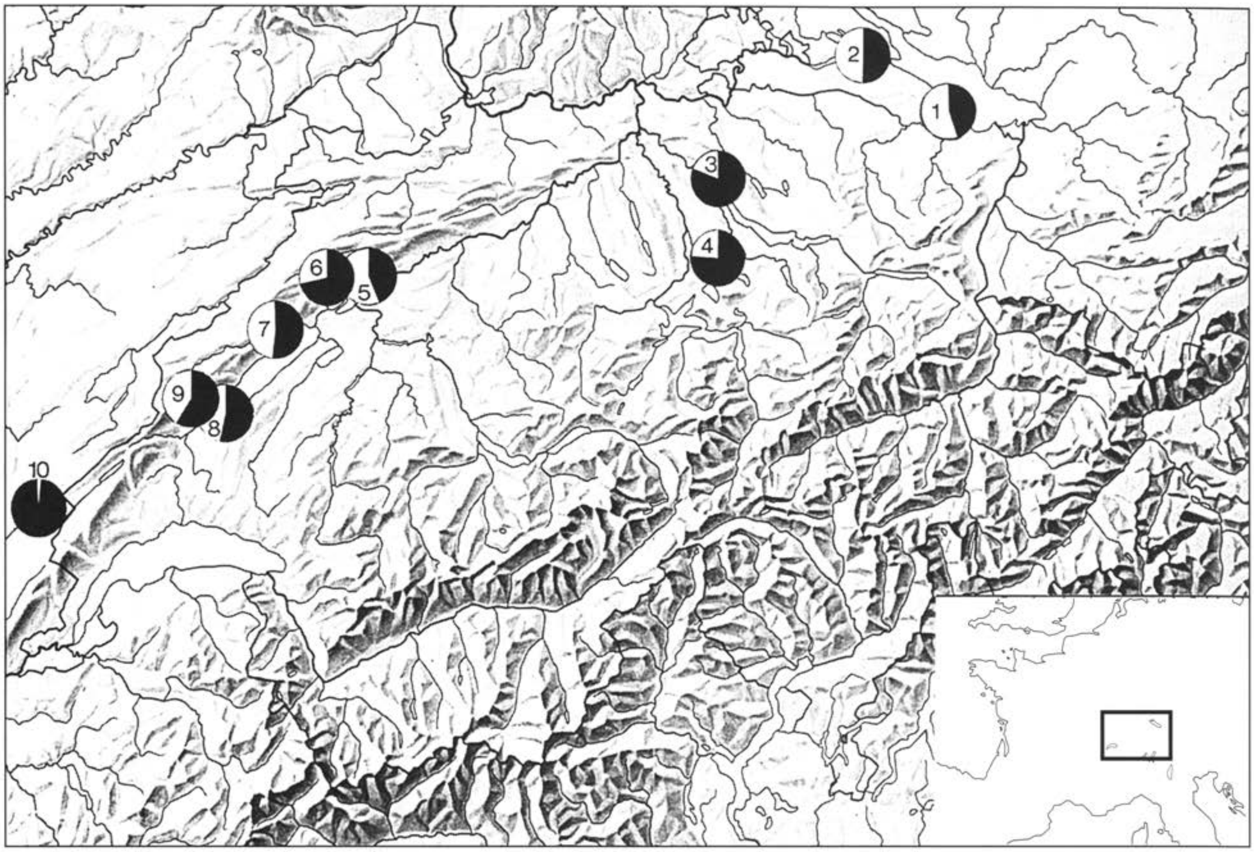

Fig. 12: Frequencies of wild animal bones (black) in settlements from the second half of the 37th and 36th centuries cal. BC in the Alpine foreland. 1, Arbon-Bleiche 3; 2, Steckborn-Schanz; 3, Zürich-Mozartstrasse layer 4; 4, Zug-Vorstadt; 5, Twann: minimum in layer E8; 6, Twann: maximum in layer E5a; 7, Auvernier-Port III; 8, Yverdon-Garage Martin 14-16b; 9, Yverdon-Garage Martin 18-20; 10, Clairvaux MM V (Arbogast and Pétrequin, 1993: fig. 3).

by only two vetrebrae and a fragment of a quadrate, respectively. This suggests that fishing was primarily focused on the shore zone for the entire occupation of this site.

When the fish remains are divided into size classes for each cultural period, a different picture becomes apparent (fig. 11). In the oldest phases (39th century cal. BC), identified as Cortaillod, small fish predominate. In general, they are rarely larger than 10 centimeters in body length. The taxa represented are mostly very young perch and carp, which occur in schools in the warm, shallow shore waters.

The following Pfyn culture (37th century cal. BC) is characterized by fewer very small individuals, and relatively more larger fish (fig. 11). The largest fish (over 80 cm long) are exclusively pike; the size class up to 50 cm includes mostly carp and perch, with only a few pike.

This indicates a shift in the fishing methods used at this site through time. The older phase documents the practice of net fishing, with fine mesh nets set out primarily in the shallows. The later phase suggests an increase in deliberate capture of larger individuals. In addition to the nets set in the shallows for schools of young carp, hooks and harpoons probably were used to fish for the larger pike. The analyses of textiles (Rast, in prep.) partially support this hypothesis: the early phase shows the most abundant remnants of fine-mesh nets. Undoubtedly the yield of fish increased in the 37th century cal. BC. The fish remains then provide additional evidence that the inhabitants were increasing their caloric intake from other sources in response to the decrease in cereal production.

Economic development and climatic changes

The drastic economic changes demonstrated for the period from 3700 to 3500 cal. BC on Lake Zürich can be traced in adjacent regions of the Alpine foreland. Increased amounts of wild animals, particularly red deer, are documented for contemporaneous stations on Lake Constance, Lake Zug, Lake Biel, Lake Neuchâtel and Lake Clairvaux (French Jura; Arbogast and Pétrequin, 1993; see fig. 12). If we assume that the increased representation of red deer in these sites reflects similar economic conditions, then the interregional distribution of this pattern suggests shared climatic conditions. A number of climatic fluctuations have been demonstrated for the Alps and Alpine foreland in the mid-Holocene (overview in Jacomet *et al.*, 1995), many of which can be identified across the entire northern hemisphere (eg. Dansgaard *et al.,* 1984). In addition to amelioration phases, characterized by increased glacial melting and elevational changes in the treeline, there is also evidence for periods of climatic deterioration. One of these cooler phases, accompanied by alpine glacial advances and a lowering of the treeline, began (based on the calibration of available dates) in the 37th century cal. BC (fig. 13: Piora II; Zoller, 1977). This climatic event is clearly visible as a transgression phase in the sediments of the lakes of the northern Alpine foreland and the Jura (fig. 13: Chalain; Magny, 1992). If we compare these fluctuations with those known from the time of the Little Ice Age to today (eg. Pfister, 1985), we see that the cool phases are marked by especially chilly and rainy summers (Magny, 1993: 308). This led not only to a rise in water level of the lakes - lakeside sites are rare in eastern Switzerland after 3600 cal. BC - but also to a higher frequency of crop failures. Such crop failures are documented in historical records from the late Middle Ages (ie. the Little Ice Age): "...the two unusually poor harvests... in the years 1566/67 were explicitly blamed on bad weather by the official. In the spring of 1566 (in the village Kappel), the wither crop was sown with oats, in an attempt to salvage at least a portion of the harvest" (after Irniger, 1991: 128).

For our time period, it is interesting to note that the beginning of long-term, climatically cool phases is actually quite abrupt. This is supported by dendroclimatic investigations from the Alps (eg. Renner, 1982). Although it is not

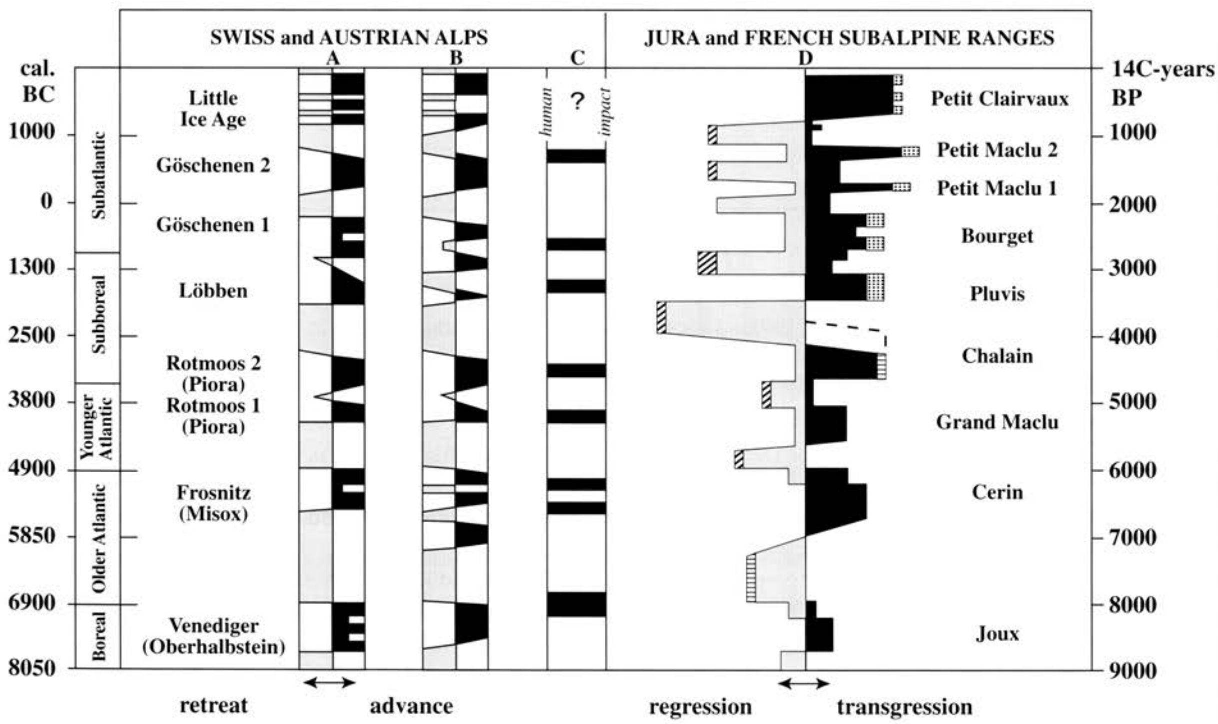

Fig. 13: Correlation between lake-level fluctuation recorded in the Jura and French subalpine ranges, glacier movements recorded in the Swiss and Austrian Alps and timber line variations. Transgressive phases (black) recorded in lakes correspond to glacier advances (black) and timber-line retreats (black). After Magny, 1992: Fig. 15, changed.

possible to exactly correlate our "economic crash" with the floating chronologies from the Gotthard area (Swiss Central Alps), there is unquestionable evidence for a climatic deterioration in the 37th century cal. BC, leading into a period of cooler, unstable weather lasting until 3200 cal. BC: lakeside sites are rare or nonexistent in this period, especially in eastern Switzerland (eg. Gross, 1990). It appears very likely, then, that this climatic event is the ultimate cause for the economic changes observed in this period of the Neolithic - and perhaps therefore also associated with the cultural shift from Pfyn to Horgen.

Conclusions

The archaeological and climatic data point to an economic crisis in the Alpine foreland in the 37th century cal. BC, which can most likely be related to a general climatic deterioration. Cool, damp summers in the second half of the century appear to have led to failed cereal harvests. The resulting decrease in calories available from cereals led the Neolithic farmers to intensify their exploitation of wild resources in an attempt to compensate for this loss. Meat consumption was increased through an intensification of red deer hunting and the use of different fishing techniques. Additional calories were obtained from increased wild plant gathering, with an emphasis on plants with nutritionally rich seeds and fruits. This economic practice continued into the 36th century cal. BC, and is apparent throughout the entire Alpine foreland. On Lake Zürich, faunal remains document changes in the age spectrum of red deer exploited through time. An intensified hunting led to the capture of increasingly younger individuals. Such continuous intensive hunting (over 100 years in duration) could have posed a severe threat to the stability of this local wild animal population. If carried to an extreme, this could have resulted in the killoff of the local red deer population. This has far-reaching technological and cultural consequences, since a widely used raw material - red deer antler - would no longer have been available. Signs of the increasing rarity of this raw material can be seen in the few known early Horgen sites in eastern Switzerland. Here, there are only occasional antler artifacts, and the previously common antler sockets, which functioned as shock-absorbing connective joints between stone axes and wooden handles, are totally absent.

It remains for future research to evaluate the role of climatic change as a causal factor in the gradual transition from Pfyn to Horgen in the 35th and 34th centuries cal. BC in eastern Switzerland, and the corresponding transition from Cortaillod to Horgen in western Switzerland.

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